Efficient Method for Image Matching using Block Similarity

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***Abstract* — Image matching is of great importance in many real-world applications. Although many traditional methods exist for image matching but they have several problems such as high computational cost problem and problem of scale invariance. For correct image matching extracting appropriate point pairs have great significance to establish the relationship for among the images to be compared. An automatic extracting method point pairs is proposed in this work. Firstly, it determines the common areas of two images and divides them into blocks uniformly. The corresponding blocks of the two images are marked with the same sequence number to establish the one-to-one regional matching relation. Then, for each block, k-means based nearest neighbor approach adopted to detect more relevant point pairs. Finally the regional matching strategy is performed to match the acquired points. The proposed method can extract control point pairs with high precision, and these point pairs conduct to improve the precision of image matching.**

***Key Words* — Block matching, image match, regional similarity, real-time application.**

I. Introduction

The goal of image matching is to decide whether a given image has been registered in the database or not. The query image may be affected with the noise, logo, scale changes etc. This work will mainly focus on how to extract exact point pairs tending to be unaffected. There are various methods for matching and retrievals. All these methods have tried to achieve greater matching rate but facing computational complexity and other problems related to invariance of scale.

The method presented in this paper try to develop points pairs that are resistant to noise, invariant to deformations, change of scale, illumination, etc. Most of image matching methods consist of usual steps extracting the features and then finding out their similarity measure. The main difficulty lies in choice of control point pairs. Therefore , the main approach here is to extract some well-defined point pairs in both reference and referenced image, and then to compute nearest neighbors using well defined k-means. This paper will focus on the common region detection and matching to acquire appropriate point pairs.

II. Background

Previously many powerful techniques has been proposed for effective image matching using nearest neighbors patch-match based approach[1,2], real time content based image matching [3] etc .But the main point here is to extract the correct point pairs using precise method .Hence the main focus of the paper is given on this area .And the method can be called as a combination of two approaches .The first approach is about the regional matching and second one is of finding the appropriate point pairs using nearest neighbor scheme .The point pairs will be the resultant outputs which are going to provide the closest matching between the input image and the reference image. The results will be definite and able to reduce misjudgment rate. The paper describes about the existing methodologies and their drawbacks. After that the improved method is explained in detail. To make it easy it is discussed in stepwise manner, where each step is fully described. The method is advantageous because it is capable to provide more accurate matching results irrespective of scale changes since it is using the hybridization of two approaches. The method can be proven to be more robust and computationally effective.

III. Related Theory

The theories for image matching process are studied by many scholars and researchers previously. Many of the most powerful of these methods are patch-based. Connelly Barnes et.al [1] presented a randomized algorithm for quickly finding approximate nearest neighbor matches between image patches. This algorithm offered substantial performance improvements over the previous state of the art algorithms .The key insight driving this algorithm is that the elements of search domain patches of image pixels are correlated, and thus the search strategy takes advantage of these statistics. However, because these algorithms must search and manipulate millions of patches, performance in many cases had previously been far from interactive. It accelerates many patch-based methods by at least an order of magnitude. Patch-based sampling methods have become a popular tool for image and video synthesis and analysis. This method is not robust to JPEG artifacts, but uses our more general matching algorithm, so it could potentially be generalized to find different types of forgeries such as those produced by automatic hole filling.

On the other hand similar technical perspective for a perfect match has been presented by William Freeman [2]. There are problems the vision and image processing community has been struggling with for many years. Many different analytic approaches have been tried, but they seldom capture the richness and subtle details needed to produce realistic images. Looking for a matching patch at random positions in the database region eventually finds good matches. Their "patch match" algorithm combines these approaches—deterministic update of a previous solution while allowing improvements from random guesses—to give a fast, approximate nearest neighbor algorithm for image patches that avoids getting stuck in bad solutions. However Yong Luo, et. al. [3] proposed a fast image matching method.ORB is introduced in this method.ORB is among the recently developed fast image descriptor which is shown to have very low computational cost with satisfactory accuracy. Proposed a strategy for matching

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decision, recommending auto-tune for projection, and investigate the influence of environmental factors.ORB is proven here to be more appropriate than SIFT (Scale Invariant Feature Transform) and SURF (Speed up robust Feature) for fast image matching in the case of the query image is contaminated. Here it is stated that histogram intersection is more appropriate than cosine similarity for fast image matching, and the method of matching proven to be effective but does not achieves satisfactory robustness.

Shiliang Zhang et.al.[4] presented another method for visual matching. Because matching duplicate visual contents among images serves as the basis of many vision tasks. Different local descriptors for image matching, e.g., floating point descriptors like SIFT, SURF, and binary descriptors like ORB and BRIEF. These descriptors either suffer from relatively expensive computation or limited robustness due to the compact binary representation. This method studied how to improve the matching efficiency and accuracy of floating point descriptors and the matching accuracy of binary descriptors. Multi-order visual phrase does not scarify the repeatability of classic visual word and is more robust to the quantization error than existing visual phrase features. Comparisons with recent retrieval approaches clearly demonstrate the competitive accuracy and significantly better efficiency of these approaches. Multi-order visual phrase effectively captures rich spatial clues and conquers the issues in existing visual phrase features, i.e., low flexibility and low repeatability. It allows more flexible matching and is more robust to quantization error. .But extracting and matching SIFT on VGA (video graphics array) sized images may cost more than 1 on modern CPUs.

One more methodology of feature based image matching using relaxation labeling technique is proposed by Jyoti Joglekar et. al.[5].It has focused on reconstruction of the 3-D geometry of an object from its image. A probabilistic neural-network-based feature matching algorithm has been proposed for a stereo image pair which is useful as a constraint initializing method for dense matching technique. In this approach, scale-invariant feature transform (SIFT) features are used to detect interest points in a stereo image pair. Reduced search area improves the computation speed. The time complexity of this algorithm however, is more as compared to the other methods.

The other methods [6], [7] are also efficient techniques for image matching but lacks in performance due to real-time variations. Method presented in [8] has tried to provide more accurate and robust result compared to pixel-wise

block matching method, but it also face problem regarding to the quality and real-time performance.

IV. Analysis and Discussion

The method in [1] compared speed and memory usage of proposed algorithm against k-d trees with dimensionality reduction, and shown that it is at least an order of magnitude faster than the best competing combination and uses significantly less memory. Preserve structures and enable local interactions. This generalized matching algorithm can operate on any common image descriptors and unlike many of the tree structures, supports any distance function. One advantage of patch sampling schemes is that they offer a great deal of fine-scale control. The algorithm, which accelerates the problem of finding nearest neighbor patches by 20–100 x over previous work. The algorithm is a randomized approximation algorithm: it does not always return the exact nearest neighbor, but returns a good approximate nearest neighbor quickly, and improves the estimate with each iteration. In contrast to all previous work, proposed reshuffling method is fully interactive but do not always produce the expected result.

Breakthrough contribution given by [2] which has developed an efficient way to find approximate nearest neighbors for the case of patches within image data. Their advance resulted from two main insights. The first is the observation, also noted by others, that the best matches from two spatially neighboring positions are usually two spatially neighboring patches from the database region .The "patch match" algorithm combines these approaches—deterministic update of a previous solution while allowing improvements from random guesses—to give a fast, approximate nearest neighbor algorithm for image patches that avoids getting stuck in bad solutions. It has also proven to be faster.

In technique proposed in [3] an efficient way has been developed to find approximate nearest neighbors for the case of patches within image data. It is one of the fast methods to guess a matching patch, given the match to the spatial neighbor. It has fixed the problems by matching patch at random positions in the database region which eventually leads to good matches. The "patch match" algorithm improved matching rate from random guesses to give a fast, approximate nearest neighbor algorithm for image patches that avoids getting stuck in bad solutions. It does allows interactive use of some remarkable image editing algorithms that were previously restricted to slow, batch processing. So there is still scope of improvement with this method.

A fast image matching method [4] where ORB is introduced, a fast image descriptor which is shown to have very low computational cost with satisfactory accuracy. ORB is proven here to be more appropriate than SIFT and SURF for fast image matching, as shown in the following table, in the case of the query image is contaminated.

Table
Comparison of matching Precision, Recall and Efficiency

Methods	SIFT	BoWs	SMVP	ORB	OMVP
Precision	0.793	0.761	0.892	0.786	0.906
Recall	100	0649	0.614	100	0.847
Time(ms)	1121	413	436	75	113

Also in this it is stated that histogram intersection is more appropriate than cosine similarity for fast image matching, and the method of matching proven to be effective but does not achieves satisfactory robustness. The k-means method is used in the method and that gives the accurate results thereby reducing the chances of unpredictable point pairs from getting elected .This is the reason in the proposed work also this technique is used.

In [5] it is shown how to improve the efficiency of floating point descriptors and the accuracy of binary descriptors by embedding the spatial clues among local descriptors. To achieve flexible matching and avoid aggregating quantization error, match two multi-order visual phrases by

1) Firstly matching their center visual words,

2) Then checking the number their neighbor key-points showing similar visual and spatial clues, i.e., the number of matched neighbor key-points.

If two of their neighbor key-points are matched, call this match as a two-order match. Similarly there are three-order and four-order matches. Multi-order visual phrase could be indexed with inverted indexes for large-scale image search. Multi-order visual phrase performs efficiently in large-scale image search. Multi-order visual phrase is a novel alternative to visual word and can be flexibly matched. It shows obvious advantages over existing visual phrases in the aspects of flexibility, efficiency, and repeatability. Extraction of multi-order visual phrase is done using following steps.

1) Extraction of multi-order visual phrase (MVP).

2) The image matching and retrieval algorithms.

The accuracy of good matches as well as the number of good matches can be improved with this approach for feature matching. This method enforces consistency considering the position of neighboring features. It has employed the Probabilistic Relaxation Algorithm with the Feature Point Extraction and Descriptor along with the Matching model.

In Feature Point Extraction and Descriptors the SIFT-based feature detector, is used to find key-points in the image pair. After analyzing the region around the location of the key-point, a descriptor is assigned to every key-point, as the region characterizes the key-point under consideration with respect to its neighboring pixels, In matching model the primary input will be a set of interest points and their descriptors, computed using the SIFT algorithm. At the end a descriptor vector of dimension $4 \times 4 \times 8$ is obtained. Thus, the descriptor vector is of size 128.

As SIFT features are scale and affine invariant, there is an increased possibility of detecting the same features in both images of a stereo pair. The advantage of this approach is that the accuracy of the initial probability estimates is more as a binary relation is used, also reducing computational complexity.

The methods which are proposed by many scholars for image matching, discussed above and hence it can be said that they are somewhere facing problems in robustness or in the computationalism. The drawbacks can be reduced by some extent with the use of proposed method in this paper, which is based on utilizing the hybrid approach for extraction of correct point pairs. It can be proven to be resistant to the scale changes and the iterative approach will apparently lead to optimal and accurate results with decreased mismatch ratio.

V. PROPOSED METHODOLOGY

Image matching is essential process used in number of applications. There are various methods previously been proposed as discussed above but there is still some improvements have to be done. This work gives an efficient and improved approach for image matching using regional matching scheme. One of the key of this method is that it will extract appropriate point pairs having great significance to establish the relationship of two images. SIFT algorithm is difficult to confirm relevant parameters, it can extract only a few feature points which are distributed unevenly. So here the nearest neighbor match approach is used. Thus it can extract a large number of point pairs necessary for the matching process. This paper tries to hybrid them to find a solution to extract control point pairs among the images with improved matching rate. The following flowchart explains very well the proposed methodology.

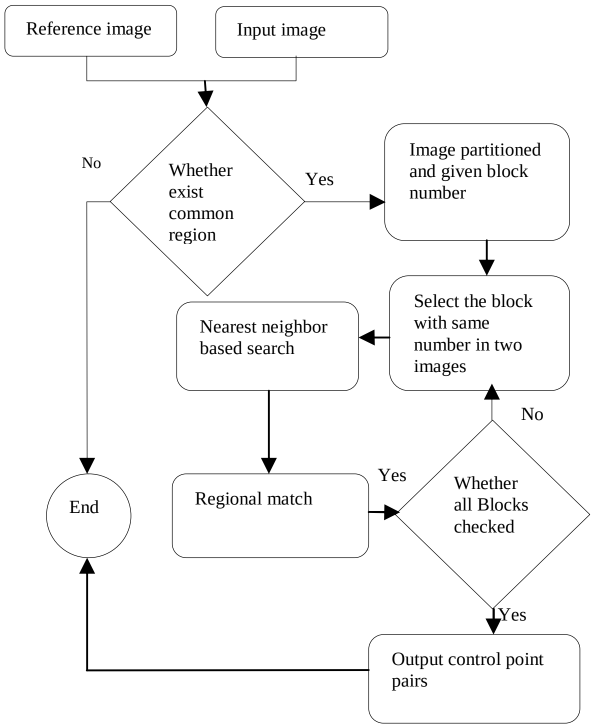

Fig. : Workflow of proposed method

Procedure of proposed workflow

In order to extract reasonable distribution and high precision point pairs between the reference and input images, the extracting procedure of control point pairs is shown in Figure 1, and the processing steps are as follows:

A) Common region Checking

The scale space of two images may be different, and generally no point pairs exist if two images have no common regional scope. If two images have common regions, then the second step goes on. The two images are checked for whether the common areas exist between the reference and input image. If there are common areas existing, then divide them into blocks.

B) Block partition

Common region between two images are divided into block uniformly, and the corresponding blocks which have the same scale range are given the same sequence number.

Assuming that the number of block is p*q, the image with the size P*Q will get （P/p）*（Q/q） blocks. For each block, a unique sequence number is assigned and make sure that the blocks which have similar scale range get the same number. So that, the i-th block in the reference and input image are referred to as Ai and Bi respectively. Block division is beneficial to the following regional matching and can reduce the computation cost to some extent.

C) Feature detecting and description

In order to extract much more features with scale and rotation invariability, two blocks which have the same sequence number are selected to building their multi-scale space, and then features are detected in each block by using method of k-d tree. The nearest neighbor match is performed. To improve this, it is common to use some well defined tree structures. The multiple randomized k-d tree [3] is effective to find nearest neighbors in regions and it certainly enhance independent search and truly will outperform in the presented method.

The standard k-means tree built by recursively checking the regions for data points. And the data points split into k distinct regions at each level using k-means clustering or grouping scheme.

D) Matching strategy

Features of corresponding block in two images are matched according to the regional matching strategy. For each block, the ratio of the nearest neighbor and second-closest neighbor is computed based on k-means tree points. If the ratio is less than a threshold, the corresponding point pair will be selected as the reasonable point pair predictable to get matched. The proposed matching decision strategy is appropriate and effective as per the final decision is considered.

CONCLUSION

An efficient method of image matching using block similarity is proposed in this paper. The control point pairs can be found for images using the scheme of regional matching. This method detects point pairs by employing approach of fast approximate nearest neighbors projection theory. Though there are certain problems associated with the change of scales among the images, it can acquire more scale invariance .The regional match strategy is used to not only reduce the computation of feature point matching, but also make the control point pair distribution reasonable and more exact. Much improved matching results can be obtained with this method resulting into the increased matching rate. This method is also beneficial to improve the accuracy of remote sensing image registration. However, method can be extended to different search domains such as 3D geometry, videos and for other new applications.

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